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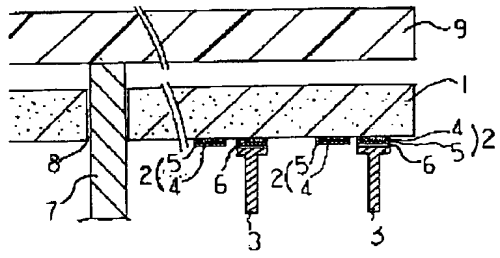
(54) HEATER AND MANUFACTURE THEREOF

(57) Abstract:

PROBLEM TO BE SOLVED: To provide a thin and light heater which can facilitate temperature control and prevent generation of thermal distortion by forming an heating element coated with a metal layer on its surface with metal particles or the metal particles and metallic oxide sintered on the surface of a plate-shaped body consisting of nitride ceramic or carbide ceramic.

SOLUTION: Fine particles of metal nitride ceramic such as AlN, or metal carbide ceramic such as SiC, are pressed and formed together with sintering assistant and binder and the like, and sintered at approx. 1,000 to 2,500°C, so that a plate-shaped body made of ceramic (heater plate) 1 is obtained, whose thickness is approx. 0.5 to 5 mm, and which is formed with a through hole 8 or the like, if necessary. Metal particles of gold, tungsten or the like, and if necessary, conductive paste including metallic oxide, such as Al_2O_3, are subjected to pattern printing, and heating sintering on the surface of the heater plate 1, and a metal coating layer 5 of Ni or the like is plating-coated on the metal particle sintered body 4 to form a heating element 2. After that, a terminal pin 3 is connected through a solder layer 6 of Ag-Pb alloy or the like.



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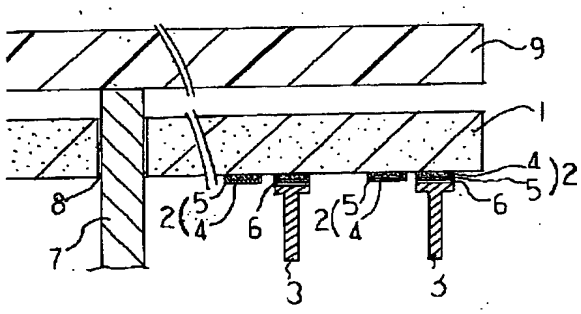
(54)【発明の名称】　ヒーターおよびその製造方法

(57)【要約】

【課題】　温度制御しやすく、薄くて軽いヒーターを提供する。

【解決手段】　金属窒化物セラミックまたは金属炭化物セラミックからなる板状体の表面に、金属粒子を焼結して形成した発熱体を設けてなる。発熱体には金属酸化物を含有してもよく、その表面をニッケル層などで被覆してもよい。



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【特許請求の範囲】

【請求項１】　窒化物セラミックまたは炭化物セラミックからなる板状体の表面に、金属粒子を焼結して形成した発熱体を設けてなることを特徴とするヒーター。

【請求項２】　前記発熱体は、金属粒子および金属酸化物を焼結して形成した請求項１に記載のヒーター。

【請求項３】　前記発熱体の表面は、金属層で被覆されてなる請求項１に記載のヒーター。

【請求項４】　少なくとも以下の①～③の工程を含むことを特徴とするヒーターの製造方法。

①窒化物セラミックまたは炭化物セラミックの粉体を焼結させて窒化物セラミックまたは炭化物セラミックからなる板状体とする工程。

②①の板状体上に金属粒子からなる導電ペーストを印刷する工程。

③加熱して導電ペーストを焼結させて、セラミックからなる板状体の表面に発熱体を設ける工程。

【請求項５】　前記工程②において、金属粒子および金属酸化物からなる導電ペーストを印刷する請求項４に記載のヒーターの製造方法。

【請求項６】　前記工程③の後、発熱体表面にめっきを行い、金属層で被覆する請求項４に記載のヒーターの製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本願発明は、主に半導体産業において使用される乾燥用のヒーターに関し、特には、温度制御しやすく、また、薄くて軽いヒーターに関する。

【０００２】

【従来の技術】半導体製品は、シリコンウエハー上に感光性樹脂をエッチングレジストとして形成し、シリコンウエハーをエッチングすることにより製造される。感光性樹脂は、液状でスピンコーターなどでシリコンウエハー表面に塗布されるのであるが、塗布後に乾燥させなければならず、塗布したシリコンウエハーをヒーター上に載置して加熱することになる。従来このようなヒーターとしては、アルミニウム板の裏面に発熱体を配線したものが採用されている。

【０００３】

【発明が解決しようとする課題】ところが、このような金属製のヒーターは次のような問題があった。まず、金属製であるため、ヒーター板の厚みは１５ｍｍ程度と厚くしなければならない。なぜなら、薄い金属板では、加熱に起因する熱膨張により、そり、歪みが発生してしまい、金属板上に載置されるウエハーが破損したり傾いたりしてしてしまうからである。このため、ヒーターの重量が大きくなり、かさばってしまう。

【０００４】また、発熱体に印加する電圧や電流量を変えることにより、加熱温度を制御するのであるが、金属板が厚いために、電圧や電流量の変化に対してヒーター板の温度が迅速に追従せず、温度制御しにくいという問題があった。本願発明は、温度制御しやすく、薄くて軽いヒーターを提供することを目的とする。

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【０００５】

【課題を解決するための手段】本願発明者らは鋭意研究した結果、ヒーター板として、金属に代えて熱伝導性に優れた窒化物セラミックまたは炭化物セラミックを使用すると、薄くしてもそり歪みが発生せず、また、発熱体に印加する電圧や電流量の変化に対してヒーター板の温度が迅速に追従するという事実を知見した。

【０００６】さらに、窒化物セラミックや炭化物セラミックは、金属粒子を含む導電ペーストとは密着しにくいのであるが、導電ペーストに金属酸化物を加えることにより、金属粒子が焼結して窒化物セラミックや炭化物セラミックと密着する事実も合わせて知見した。

【０００７】本願発明の構成は次とおりである。

１．窒化物セラミックまたは炭化物セラミックからなる板状体の表面に、金属粒子を焼結して形成した発熱体を設けてなることを特徴とするヒーター。

【０００８】２．前記発熱体は、金属粒子および金属酸化物を焼結して形成した１に記載のヒーター。

３．前記発熱体の表面は、金属層で被覆されてなる１に記載のヒーター。

【０００９】４．少なくとも以下の①～③の工程を含むことを特徴とするヒーターの製造方法。

①窒化物セラミックまたは炭化物セラミックの粉体を焼結させて窒化物セラミックまたは炭化物セラミックからなる板状体とする工程。

②①の板状体上に金属粒子からなる導電ペーストを印刷する工程。

③加熱して導電ペーストを焼結させて、セラミックからなる板状体の表面に発熱体を設ける工程。

【００１０】５．前記工程②において、金属粒子および金属酸化物からなる導電ペーストを印刷する４に記載のヒーターの製造方法。

６．前記工程③の後、発熱体表面にめっきを行い、金属層で被覆する４に記載のヒーターの製造方法。

【００１１】本願発明では、板状体（以下ヒーター板と称す）は、窒化物セラミックまたは炭化物セラミックからなることが必要である。窒化物セラミックまたは炭化物セラミックは、熱膨張係数が金属より小さく、薄くしても、加熱によりそったり、歪んだりしない。そのため、ヒーター板を薄くて軽いものとすることができる。また、ヒーター板の熱伝導率が高く、またヒーター板自体薄いため、ヒーター板の表面温度が、発熱体の温度変化に迅速に追従する。即ち、電圧、電流量を変えて発熱体の温度を変化させることにより、ヒーター板の表面温度を制御できるのである。

【００１２】前記ヒーター板は、０．５～５ｍｍ程度が

よい。薄すぎると破損しやすくなるからである。前記窒化物セラミックは、金属窒化物セラミック、例えば、窒化アルミニウム、窒化ケイ素、窒化ホウ素、窒化チタンから選ばれる少なくとも１種以上が望ましい。

【００１３】また、炭化物セラミックは、金属炭化物セラミック、例えば、炭化ケイ素、炭化ジルコニウム、炭化チタン、炭化タンタル、炭化タンステンから選ばれる少なくとも１種以上が望ましい。これらのセラミックの中で窒化アルミニウムが最も好適である。熱伝導率が１８０W／m・Kと最も高いからである。

【００１４】本願発明では、発熱体は、導電ペースト中の金属粒子を焼結して形成したものであることが必要である。加熱焼成によりセラミック板表面に焼き付けることができるからである。なお、焼結は、金属粒子同士、金属粒子とセラミックが融着していれば十分である。図１に示すように発熱体２は、ヒーター板１全体の温度を均一にする必要があることから、同心円状のパターンがよい。また、発熱体２のパターンの厚さは、１～２０μmが望ましく、幅は０．５～５mmが望ましい。厚さ、幅により抵抗値を変化させることができるが、この範囲が最も実用的だからである。抵抗値は、薄く、細くなるほど大きくなる。

【００１５】導電ペーストは、金属粒子の他、樹脂、溶剤、増粘剤などを含むものが一般的である。金属粒子としては、金、銀、白金、パラジウム、鉛、タングステン、ニッケルから選ばれる少なくとも１種以上がよい。これらの金属は比較的酸化しにくく、発熱するに十分な抵抗値を有するからである。これら金属粒子の粒径は、０．１～１００μmであることが望ましい。微細すぎると酸化しやすく、大きすぎると焼結しにくくなり、抵抗値が大きくなるからである。

【００１６】導電ペーストに使用される樹脂としては、エポキシ樹脂、フェノール樹脂などがよい。また、溶剤としては、イソプロピルアルコールなどが使用される。増粘剤としては、セルロースなどが挙げられる。

【００１７】前記導電ペーストには、金属粒子に加えて金属酸化物を含ませて、発熱体を金属粒子および金属酸化物を焼結させたものとすることが望ましい。この理由は、窒化物セラミックまたは炭化物セラミックと金属粒子を密着させるためである。金属酸化物により、窒化物セラミックまたは炭化物セラミックと金属粒子との密着性が改善される理由は明確ではないが、金属粒子表面および窒化物セラミックまたは炭化物セラミックの表面はわずかに酸化膜が形成されており、この酸化膜同士が金属酸化物を介して焼結して一体化し、金属粒子と窒化物セラミックまたは炭化物セラミックが密着するのではないかと推定している。

【００１８】前記金属酸化物としては、酸化鉛、酸化亜鉛、シリカ、酸化ホウ素（B_2O_3）、アルミナ、イットリア、チタニアから選ばれる少なくとも１種以上がよい。これらの酸化物は、発熱体の抵抗値を大きくすることなく、金属粒子と窒化物セラミックまたは炭化物セラミックとの密着性を改善できるからである。

【００１９】本願発明では、発熱体の表面は、金属層で被覆されてなることが望ましい。発熱体は、金属粒子の焼結体であり、露出していると酸化しやすく抵抗値が変化してしまう。そこで、表面を金属層で被覆することにより、酸化を防止できるのである。金属層の厚さは、０．１～１０μmが望ましい。発熱体の抵抗値を変化させることなく、発熱体の酸化を防止できる範囲だからである。

【００２０】被覆に使用される金属は、非酸化性の金属であればよい。具体的には、金、銀、パラジウム、白金、ニッケルから選ばれる少なくとも１種以上がよい。なかでもニッケルが好適である。発熱体には電源と接続するための端子が必要であり、この端子は、半田を介して発熱体に取り付けるが、ニッケルは半田の熱拡散を防止するからである。接続端子は、コバール製の端子ピンを使用することができる。

【００２１】また、半田は銀ー鉛、鉛ースズ、ビスマスースズなどの合金を使用することができる。なお、半田層の厚さは、０．１～５０μmが望ましい。半田による接続を確保するに充分な範囲だからである。本願発明では、必要に応じてヒーター板に熱電対を埋め込んでおくことができる。熱電対によりヒーター板の温度を測定し、そのデータをもとに電圧、電流量を変えて、ヒーター板の温度を制御することができるからである。

【００２２】また、図２に示すようにヒーター板１に貫通孔８を複数設けてその孔８に支持ピン７を挿入し、半導体ウエハー９をそのピン７上に載置することができる。また、支持ピン７を上下させて半導体ウエハー９を図示しない搬送機に渡したり、搬送機から半導体ウエハー９を受け取ったりすることができる。

【００２３】ついで、ヒーターの製造方法について説明する。

（１）窒化物セラミックまたは炭化物セラミックの粉体を焼結させて窒化物セラミックまたは炭化物セラミックからなる板状体（ヒーター板）を形成する工程。前述した窒化アルミニウムなどの窒化物セラミックまたは炭化ケイ素などの炭化物セラミックの粉体、必要に応じてイットリアなどの焼結助剤、バインダーをスプレードライなどの方法で顆粒状にし、この顆粒を金型などに入れて加圧し、板状に成形して生成形体を製造する。

【００２４】生成形体に、必要に応じて半導体ウエハーの支持ピンを挿入する貫通孔や熱電対を埋め込む凹部を設けておくことができる。次に、この生成形体を加熱焼成して焼結させてセラミック製の板状体を製造する。加熱焼成の際、加圧することにより気孔のないヒーター板を製造することができる。加熱焼成は、焼結温度以上であればよいが、窒化物セラミックまたは炭化物セラミッ

クでは、１０００～２５００℃である。

【００２５】（２）①のセラミック製の板状体（ヒーター板）に金属粒子からなる導電ペーストを印刷する工程。導電ペーストは、一般に、金属粒子、樹脂、溶剤からなる粘度の高い流動物である。この導電ペーストをスクリーン印刷などで発熱体を設けようとする部分に印刷する。発熱体は、ヒーター板全体を均一な温度にする必要があることから、図１に示すような同心円からなるパターンに印刷することが望ましい。

【００２６】（３）加熱して導電ペーストを焼結させて、セラミック製の板状体（ヒーター板）の表面に発熱体を設ける工程。導電ペーストを加熱焼成して、樹脂、溶剤を除去するとともに、金属粒子を焼結させる。加熱焼成温度は、５００～１０００℃である導電ペースト中に金属酸化物を添加しておくと、金属粒子、セラミック製の板状体および金属酸化物が焼結して一体化するため、発熱体とセラミック製の板状体との密着性が向上する。

【００２７】（４）さらに発熱体表面に金属層を被覆することが望ましい。被覆は、電解めっき、無電解めっき、スパッタリングにより行うことができるが、量産性を考慮すると無電解めっきが最適である。

（５）発熱体のパターンの端部に電源との接続のための端子を半田にて取りつける。

【００２８】取りつけ部位に半田ペーストを印刷した後、端子を乗せて、加熱してリフローする。加熱温度は、２００～５００℃が好適である。さらに、必要に応じて熱電対を埋め込むことができる。以下、実施例に沿って説明する。

【００２９】

【実施例】

（実施例１）　窒化アルミニウムセラミック板

（１）窒化アルミニウム粉末（平均粒径１．１μｍ）１００重量部、イットリア（酸化イットリウムのこと　平均粒径０．４μｍ）４重量部、アクリルバイダー１２重量部およびアルコールからなる組成物を、スプレードライヤー法にて顆粒状にした。

【００３０】（２）顆粒状粉末を金型に入れて、平板状に成形して生成形体を得た。生成形体にドリル加工して、半導体ウエハー支持ピンを挿入する孔８、図示しないが、熱電対を埋め込むための凹部を設けた。

（３）生成形体を１８００℃、圧力２３０ｋｇ／ｃｍ²でホットプレスし、厚さ３ｍｍの窒化アルミニウム板状体を得た。これを直径２３０ｍｍの円状に切り出してセラミック製の板状体（ヒーター板）１とした。

【００３１】（４）（３）で得たヒーター板１に、スクリーン印刷にて導電ペーストを印刷した。印刷パターンは、図１に示すような同心円のパターンとした。導電ペーストは、徳力化学研究所製のソルベストＰＳ６０３を使用した。この導電ペーストは、銀／鉛ペーストであり、金属酸化物を含むものである。

（５）導電ペーストを印刷したヒーター板を７８０℃で加熱焼成して、導電ペースト中の銀、鉛を焼結させるとともにヒーター板１に焼き付けた。銀－鉛の焼結体４によるパターンは、厚さが５μｍ、幅２．４ｍｍであった。

【００３２】（６）硫酸ニッケル８０ｇ／ｌ、次亜リン酸ナトリウム２４ｇ／ｌ、酢酸ナトリウム１２ｇ／ｌ、ほう酸８ｇ／ｌ、塩化アンモニウム６ｇ／ｌの濃度の水溶液からなる無電解ニッケルめっき浴に（５）のヒーター板を浸漬して、銀－鉛の焼結体４の表面に厚さ１μｍのニッケル層５を析出させて発熱体２とした。

【００３３】（７）電源との接続を確保するための端子を取りつける部分に、スクリーン印刷１より、銀－鉛半田ペーストを印刷して半田層（田中貴金属製）６を形成した。ついで、半田層６の上にコバール製の端子ピン３を載置して、４２０℃で加熱リフローし、端子ピン３を発熱体２の表面に取りつけた。

（８）温度制御のための熱電対（図示しない）を埋め込み、ヒーター１００を得た。

【００３４】（実施例２）　炭化ケイ素セラミック板

実施例１と基本的に同様であるが、平均粒径１．０μｍの炭化ケイ素粉末を使用し、焼結温度を１９００℃とした。

【００３５】実施例１、２のヒーターについて、電圧、電流量の変化に対する温度の追従性、発熱体のプル強度について測定した。ヒーターに電圧を印加したところ、実施例１のヒーターは０．５秒で温度変化が見られ、また、実施例２のヒーターは２秒で温度変化が観察された。発熱体２のプル強度については、実施例１のヒーターは、３．１ｋｇ／ｍｍ²、実施例２のヒーターは、３ｋｇ／ｍｍ²であった。

【００３６】（比較例）　アルミニウム板

発熱体としてシリコンゴムで挟持したニクロム線を用い、厚さ１５ｍｍのアルミニウム板とあて板を発熱体を挟み、ボルトで固定してヒーターとした。比較例のヒーターに電圧を印加したところ、温度変化が見られるまで２４秒を要した。

【００３７】

【発明の効果】以上説明のように、本願発明のヒーターは、薄く、軽くすることができ、実用的である。また、板状体として窒化物セラミックまたは炭化物セラミックを使用し、かつ薄くしているため、電圧、電流量の変化に対する温度追従性に優れており、温度制御しやすい。

【図面の簡単な説明】

【図１】本願発明のヒーターの模式図

【図２】本願発明のヒーターの使用状態を表す断面図

【符号の説明】

１　セラミック製の板状体（ヒーター板）

２　発熱体

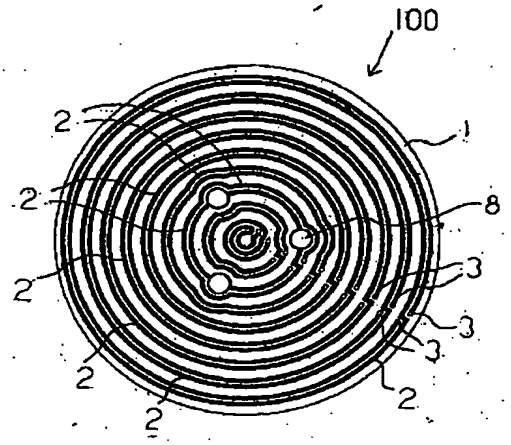
7

3　端子ピン
4　金属（銀－鉛）粒子焼結体
5　金属（ニッケル）被覆層
6　半田層

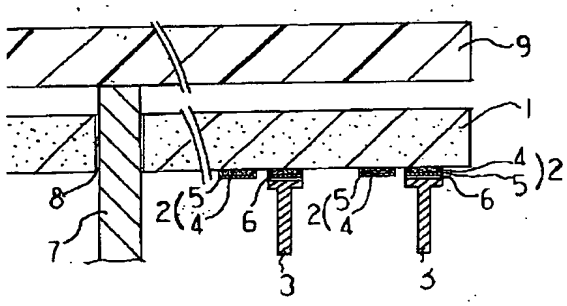
8

＊７　半導体ウエハー支持ピン
8　貫通孔
9　半導体製品
＊　１００　ヒーター

【図１】



【図２】



PATENT ABSTRACTS OF JAPAN

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(71)Applicant : IBIDEN CO LTD

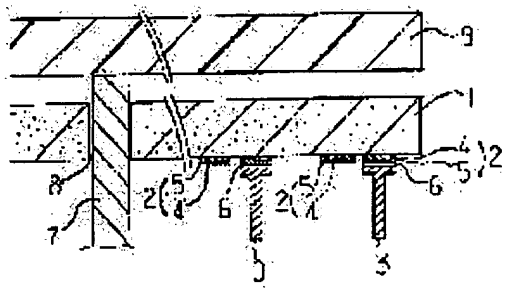
(72)Inventor : FURUKAWA MASAKAZU

(54) HEATER AND MANUFACTURE THEREOF

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a thin and light heater which can facilitate temperature control and prevent generation of thermal distortion by forming an heating element coated with a metal layer on its surface with metal particles or the metal particles and metallic oxide sintered on the surface of a plate-shaped body consisting of nitride ceramic or carbide ceramic.

SOLUTION: Fine particles of metal nitride ceramic such as AlN, or metal carbide ceramic such as SiC, are pressed and formed together with sintering assistant and binder and the like, and sintered at approx. 1,000 to 2,500°C, so that a plate-shaped body made of ceramic (heater plate) 1 is obtained, whose thickness is approx. 0.5 to 5 mm, and which is formed with a through hole 8 or the like, if necessary. Metal particles of gold, tungsten or the like, and if necessary, conductive paste including metallic oxide, such as Al2O3, are subjected to pattern printing, and heating sintering on the surface of the heater plate 1, and a metal coating layer 5 of Ni or the like is plating-coated on the metal particle sintered body 4 to form a heating element 2. After that, a terminal pin 3 is connected through a solder layer 6 of Ag-Pb alloy or the like.



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[Date of registration]	02.03.2001
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[Date of extinction of right]	

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CLAIMS

[Claim(s)]
[Claim 1] The heater which prepares the heating element which sintered and formed metal particles in the front face of the plate which consists of a nitride ceramic or a carbide ceramic, and is characterized by the bird clapper.
[Claim 2] The aforementioned heating element is the heater according to claim 1 which sintered and formed metal particles and the metallic oxide.
[Claim 3] The front face of the aforementioned heating element is a heater according to claim 1 which it comes to cover with a metal layer.
[Claim 4] The manufacture method of the heater characterized by including the process of ** of the following - ** at least.
** The process used as the plate which is made to sinter the fine particles of a nitride ceramic or a carbide ceramic, and consists of a nitride ceramic or a carbide ceramic.
The process which prints the electric conduction paste which consists of metal particles on the plate of ****.
** The process which prepares a heating element in the front face of the plate which heats, is made to sinter an electric conduction paste and consists of a ceramic.
[Claim 5] The manufacture method of the heater according to claim 4 which prints the electric conduction paste which consists of metal particles and a metallic oxide in the aforementioned process **.
[Claim 6] The manufacture method of the heater according to claim 4 which galvanizes on a heating element front face after the aforementioned process **, and is covered with a metal layer.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] About the heater for dryness mainly used in semiconductor industry, especially, it is easy to carry out the temperature control of the invention in this application, and it relates to a thin and light heater.
[0002]
[Description of the Prior Art] A semiconductor product forms a photopolymer as an etching resist on a silicon wafer, and is manufactured by **********ing a silicon wafer. Although a photopolymer is liquefied and is applied to a silicon wafer front face by the spin coater etc., it must be made to dry after an application, and it will lay the applied silicon wafer on a heater, and will heat it. As such [conventionally] a heater, what wired the rear face of an aluminum plate in the heating element is adopted.
[0003]
[Problem(s) to be Solved by the Invention] However, such a metal heater had the following problems. First, since it is metal, you have to thicken thickness of a heater board with about 15mm. It is because the wafer which it curves, and distortion occurs according to the thermal expansion resulting from heating in a thin metal plate, and is laid on a metal plate damages, or inclines and carries out. For this reason, the weight of a heater will become large and it will be bulky.
[0004] Moreover, although heating temperature was controlled by changing the voltage and the amount of current which are impressed to a heating element, since the metal plate was thick, to change of voltage or the amount of current, the temperature of a heater board did not follow quickly but there was a problem of being hard to carry out a temperature control. It is easy to carry out the temperature control of the invention in this application, and it aims at offering a thin and light heater.
[0005]
[Means for Solving the Problem] Invention-in-this-application persons did the knowledge of the fact that the temperature of a heater board follows quickly to change of the voltage which shaves even if it makes it thin, and distortion does not generate, and is impressed to a heating element, or the amount of current, when the nitride ceramic or carbide ceramic which replaced with the metal and was excellent in thermal conductivity as a heater board as a result of inquiring wholeheartedly was used.
[0006] Furthermore, by adding a metallic oxide to an electric conduction paste, metal particles sintered the nitride ceramic and the carbide ceramic, and although it was hard to stick, they also doubled the fact to stick with the nitride ceramic or the carbide ceramic, and carried out knowledge to the electric conduction paste containing metal particles.
[0007] The composition of the invention in this application is as follows.
1. Heater which prepares heating element which sintered and formed metal particles in front face of plate which consists of nitride ceramic or carbide ceramic, and is characterized by bird clapper.
[0008] 2. The aforementioned heating element is a heater given in 1 which sintered and formed metal particles and the metallic oxide.

3. The front face of the aforementioned heating element is a heater given in 1 which it comes to cover with a metal layer.
[0009] 4. Manufacture method of heater characterized by including process of ** of the following - ** at least.
** The process used as the plate which is made to sinter the fine particles of a nitride ceramic or a carbide ceramic, and consists of a nitride ceramic or a carbide ceramic.
The process which prints the electric conduction paste which consists of metal particles on the plate of ****.
** The process which prepares a heating element in the front face of the plate which heats, is made to sinter an electric conduction paste and consists of a ceramic.
[0010] 5. Manufacture method of heater given in 4 which prints electric conduction paste which consists of metal particles and metallic oxide in aforementioned process **.
6. Manufacture method of heater given in 4 which galvanizes on heating element front face after aforementioned process **, and is covered with metal layer.
[0011] In the invention in this application, a nitride ceramic or a carbide ceramic to a bird clapper is required for a plate (a heater board is called below). Do not meet by heating, it is not distorted, or a nitride ceramic or a carbide ceramic is not carried out, even if a coefficient of thermal expansion is smaller than a metal and makes it thin. Therefore, let a heater board be a thin and light thing. moreover, the thermal conductivity of a heater board -- high -- moreover, the heater board itself -- since it is thin, the skin temperature of a heater board follows the temperature change of a heating element quickly That is, the skin temperature of a heater board is controllable by changing voltage and the amount of current and changing the temperature of a heating element.
[0012] The aforementioned heater board has about 0.5-5 goodmm. It is because it will become easy to damage if too thin. The aforementioned nitride ceramic has at least one or more desirable sorts chosen from a metal nitride ceramic, for example, alumimium nitride, silicon nitride, boron nitride, and a titanium nitride.
[0013] Moreover, a carbide ceramic has at least one or more desirable sorts chosen from a metal carbide ceramic, for example, silicon carbide, a zirconium carbide, a titanium carbide, a tantalum carbide, and a carbonization wardrobe ten. Alumimium nitride is the most suitable in these ceramics. It is because thermal conductivity is as the highest as 180 W/m-K.
[0014] At the invention in this application, a heating element needs to sinter and form the metal particles under electric conduction paste. It is because it can print on a ceramic board front face by heating baking. In addition, sintering is enough if metal particles, metal particles, and the ceramic are welding. As shown in drawing 1 , since a heating element 2 needs to make temperature of the heater board 1 whole uniform, its concentric circle-like pattern is good. Moreover, the thickness of the pattern of a heating element 2 has desirable 1-20 micrometers, and 0.5-5mm of width of face is desirable. It is because this range is the most practical although resistance can be changed with thickness and width of face. Resistance becomes so large that it becomes thinly and thin.
[0015] An electric conduction paste has a common thing containing a resin besides metal particles, a solvent, a thickener, etc. As metal particles, at least one or more sorts chosen from gold, silver, platinum, palladium, lead, a tungsten, and nickel are good. These metals are because it has sufficient resistance comparatively to be hard to oxidize and generate heat. As for the particle size of these metal particles, it is desirable that it is 0.1-100 micrometers. It is because will be easy to oxidize if too detailed, it will be hard coming to sinter if too large, and resistance becomes large.
[0016] As a resin used for an electric conduction paste, an epoxy resin, phenol resin, etc. are good. Moreover, isopropyl alcohol etc. is used as a solvent. A cellulose etc. is mentioned as a thickener.
[0017] It is desirable to have included the metallic oxide in the aforementioned electric conduction paste in addition to metal particles, and to have made it sinter metal particles and a metallic oxide for a heating element. This reason is for sticking a nitride ceramic or a carbide ceramic, and metal particles. Although the reason the adhesion of a nitride ceramic or a carbide ceramic, and metal particles is improved by the metallic oxide is not clear, the oxide film is formed slightly, these oxide films sintered and unified the

front face of a metal-particles front face and a nitride ceramic, or a carbide ceramic through the metallic oxide, and it is presumed whether metal particles, a nitride ceramic, or a carbide ceramic sticks.
[0018] As the aforementioned metallic oxide, at least one or more sorts chosen from a lead oxide, a zinc oxide, a silica, boron oxide (B-2 O3), an alumina, a yttria, and a titania are good. These oxides are because adhesion with metal particles, a nitride ceramic, or a carbide ceramic can be improved without enlarging the resistance of a heating element.
[0019] In the invention in this application, the front face of a heating element is covered with a metal layer, and its bird clapper is desirable. A heating element is a sintered compact of metal particles, and resistance will change that it will be easy to oxidize if it has exposed. Then, oxidization can be prevented by covering a front face with a metal layer. Metal layer thickness has desirable 0.1-10 micrometers. It is because it is the range which can prevent oxidization of a heating element, without changing the resistance of a heating element.
[0020] The metal used for covering should just be a metal of a non-oxidizing quality. Specifically, at least one or more sorts chosen from gold, silver, palladium, platinum, and nickel are good. Nickel is suitable especially. Although the terminal for connecting with a power supply is required for a heating element and this terminal is attached in a heating element through solder, nickel is because the thermal diffusion of solder is prevented. An end-connection child can use the terminal pin made from covar.
[0021] Moreover, solder can use alloys, such as silver-lead and lead-tin and bismuth-tin. In addition, solder layer thickness has desirable 0.1-50 micrometers. It is because it is sufficient range to secure connection by solder. In the invention in this application, a thermocouple can be embedded to a heater board if needed. It is because the temperature of a heater board can be measured with a thermocouple, voltage and the amount of current can be changed based on the data and the temperature of a heater board can be controlled.
[0022] Moreover, as shown in drawing 2 , two or more breakthroughs 8 can be formed in the heater board 1, the support pin 7 can be inserted in the hole 8, and the semiconductor wafer 9 can be laid on the pin 7. Moreover, the conveyance machine which is made to go up and down the support pin 7, and does not illustrate the semiconductor wafer 9 can be passed, or the semiconductor wafer 9 can be received from a conveyance machine.
[0023] Subsequently, the manufacture method of a heater is explained.
(1) The process which forms the plate (heater board) which is made to sinter the fine particles of a nitride ceramic or a carbide ceramic, and consists of a nitride ceramic or a carbide ceramic. Sintering acids, such as a yttria, and a binder are made into the shape of granulatio by methods, such as spray dry, the fine particles of carbide ceramics, such as nitride ceramics, such as alumimium nitride mentioned above, or silicon carbide, and if needed, this granulatio is put into metal mold etc., and is pressurized, it fabricates to a tabular, and a generation form is manufactured.
[0024] The crevice embedding the breakthrough which inserts the support pin of a semiconductor wafer in a generation form if needed, or a thermocouple can be prepared. Next, carry out heating baking, this generation form is made to sinter, and the plate made from a ceramic is manufactured. A heater board without pore can be manufactured by pressurizing in the case of heating baking. Although heating baking should just be more than sintering temperature, it is 1000-2500 degrees C with a nitride ceramic or a carbide ceramic.
[0025] (2) Process which prints the electric conduction paste which becomes a plate made from the ceramic of ** (heater board) from metal particles. An electric conduction paste is a fluid with the viscosity high generally which consists of metal particles, a resin, and a solvent. This electric conduction paste is printed into the portion which is going to prepare a heating element by screen-stencil etc. Since a heating element needs to make the whole heater board uniform temperature, it is desirable to print to the pattern which consists of a concentric circle as shown in drawing 1 .
[0026] (3) The process which heats, is made to sinter an electric conduction paste and prepares a heating element in the front face of the plate made from a ceramic (heater board). Metal particles are made to sinter, while carrying out heating baking of the electric conduction paste and removing a resin and a solvent. If the metallic oxide is added during the electric conduction paste which is 500-1000 degrees C,

since the plate and metallic oxide made from metal particles and a ceramic will sinter and unify, the adhesion of heating burning temperature of a heating element and the plate made from a ceramic improves.
[0027] (4) It is desirable to cover a metal layer on a heating element front face further. Although electrolysis plating, electroless plating, and sputtering can perform covering, electroless plating is the optimal if mass-production nature is taken into consideration.
(5) Attach the terminal for connection with a power supply in the edge of the pattern of a heating element with solder.
[0028] After printing a soldering paste to an attachment part, a reflow of the terminal is put, heated and carried out. 200-500 degrees C is suitable for heating temperature. Furthermore, a thermocouple can be embedded if needed. Hereafter, it explains in accordance with an example.
[0029]
[Example]
(Example 1) The constituent which consists of the alumimium nitride ceramic board (1) alumimium-nitride powder (1.1 micrometers of mean particle diameters) 100 weight section, the yttria (0.4 micrometers of mean particle diameters [A yttrium oxide]) 4 weight section, the acrylic BAIDA 12 weight section, and alcohol was made into the shape of granulatio by the spray-dryer method.
[0030] (2) Granulatio-like powder was put into metal mold, it fabricated to plate-like, and the generation form was acquired. Drilling was carried out to the generation form and the crevice the hole 8 which inserts a semiconductor wafer support pin, and for embedding a thermocouple, although not illustrated was prepared.
(3) It is a generation form 1800 degrees C and pressure 230 kg/cm2 The hotpress was carried out and the alumimium nitride plate with a thickness of 3mm was obtained. This was started with a diameter of 230mm in the shape of a circle, and it considered as the plate 1 made from a ceramic (heater board).
[0031] To the heater board 1 obtained by (4) and (3), the electric conduction paste was printed by screen-stencil. The printing pattern was used as the pattern of a concentric circle as shown in drawing 1 . The electric conduction paste used the **** chemical research center Solvay strike PS 603. This electric conduction paste is silver / lead paste, and contains a metallic oxide.
(5) Heating baking of the heater board which printed the electric conduction paste was carried out at 780 degrees C, and while making the silver under electric conduction paste, and lead sinter, it printed on the heater board 1. The thickness of the pattern by the sintered compact 4 of silver-lead was 2.4mm in 5 micrometers and width of face.
[0032] (6) The heater board of (5) was immersed in the non-electrolyzed nickel-plating bath which consists of solution of the concentration of nickel-sulfate 80 g/l, sodium hypophosphite 24 g/l, sodium acetate 12 g/l, a 8g [/l.] way acid, and ammonium-chloride 6 g/l, and on the front face of the sintered compact 4 of silver-lead, the nickel layer 5 with a thickness of 1 micrometer was deposited, and was used as the heating element 2.
[0033] (7) From screen-stencil 1, the silver-lead soldering paste was printed into the portion which attaches the terminal for securing connection with a power supply, and the solder layer (product made from the Tanaka noble metals) 6 was formed in it. Subsequently, the terminal pin 3 made from covar was laid on the solder layer 6, a heating reflow was carried out at 420 degrees C, and the terminal pin 3 was attached in the front face of a heating element 2.
(8) The thermocouple for a temperature control (not shown) was embedded and the heater 100 was obtained.
[0034] (Example 2) With the silicon carbide ceramic board example 1, although it was fundamentally the same, the silicon carbide powder of 1.0 micrometers of mean particle diameters was used, and sintering temperature was made into 1900 degrees C.
[0035] It measured about the flattery nature [as opposed to / heater / of examples 1 and 2] change of voltage and the amount of current / of temperature, and the pull intensity of a heating element. When voltage was impressed to the heater, as for the heater of an example 1, the temperature change was seen in 0.5 seconds, and, as for the heater of an example 2, the temperature change was observed in 2

seconds. the pull intensity of a heating element 2 -- the heater of an example 1 -- the heater of 3.1kg/mm2 and an example 2 -- 3kg/mm2 it was .
[0036] (Example of comparison) Using the nichrome wire pinched by silicone rubber as an aluminum plate heating element, it hit with the aluminum plate with a thickness of 15mm, and the heating element was inserted, it fixed with the bolt, and the board was used as the heater. 24 seconds was taken to see a temperature change, when voltage was impressed to the heater of the example of comparison.
[0037]
[Effect of the Invention] Like explanation, the heater of the invention in this application can be made thinly and light, and is above practical. Moreover, a nitride ceramic or a carbide ceramic is used as a plate, and since it is made thin, it excels in the temperature flattery nature to change of voltage and the amount of current, and it is a temperature-control plain-gauze cone.

[Translation done.]

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TECHNICAL FIELD

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PRIOR ART

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TECHNICAL PROBLEM

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MEANS

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[0006] Furthermore, by adding a metallic oxide to an electric conduction paste, metal particles sintered the nitride ceramic and the carbide ceramic, and although it was hard to stick, they also doubled the fact to stick with the nitride ceramic or the carbide ceramic, and carried out knowledge to the electric conduction paste containing metal particles.
[0007] The composition of the invention in this application is as follows.
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[0008] 2. The aforementioned heating element is a heater given in 1 which sintered and formed metal particles and the metallic oxide.
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The process which prints the electric conduction paste which consists of metal particles on the plate of ****.
** The process which prepares a heating element in the front face of the plate which heats, is made to sinter an electric conduction paste and consists of a ceramic.
[0010] 5. Manufacture method of heater given in 4 which prints electric conduction paste which consists of metal particles and metallic oxide in aforementioned process **.
6. Manufacture method of heater given in 4 which galvanizes on heating element front face after aforementioned process **, and is covered with metal layer.
[0011] In the invention in this application, a nitride ceramic or a carbide ceramic to a bird clapper is required for a plate (a heater board is called below). Do not meet by heating, it is not distorted, or a nitride ceramic or a carbide ceramic is not carried out, even if a coefficient of thermal expansion is smaller than a metal and makes it thin. Therefore, let a heater board be a thin and light thing. moreover, the thermal conductivity of a heater board -- high -- moreover, the heater board itself -- since it is thin, the skin temperature of a heater board follows the temperature change of a heating element quickly That is, the skin temperature of a heater board is controllable by changing voltage and the amount of current and changing the temperature of a heating element.
[0012] The aforementioned heater board has about 0.5-5 goodmm. It is because it will become easy to damage if too thin. The aforementioned nitride ceramic has at least one or more desirable sorts chosen

from a metal nitride ceramic, for example, alumimium nitride, silicon nitride, boron nitride, and a titanium nitride.
[0013] Moreover, a carbide ceramic has at least one or more desirable sorts chosen from a metal carbide ceramic, for example, silicon carbide, a zirconium carbide, a titanium carbide, a tantalum carbide, and a carbonization wardrobe ten. Alumimium nitride is the most suitable in these ceramics. It is because thermal conductivity is as the highest as 180 W/m-K.
[0014] At the invention in this application, a heating element needs to sinter and form the metal particles under electric conduction paste. It is because it can print on a ceramic board front face by heating baking. In addition, sintering is enough if metal particles, metal particles, and the ceramic are welding. As shown in drawing 1 , since a heating element 2 needs to make temperature of the heater board 1 whole uniform, its concentric circle-like pattern is good. Moreover, the thickness of the pattern of a heating element 2 has desirable 1-20 micrometers, and 0.5-5mm of width of face is desirable. It is because this range is the most practical although resistance can be changed with thickness and width of face. Resistance becomes so large that it becomes thinly and thin.
[0015] An electric conduction paste has a common thing containing a resin besides metal particles, a solvent, a thickener, etc. As metal particles, at least one or more sorts chosen from gold, silver, platinum, palladium, lead, a tungsten, and nickel are good. These metals are because it has sufficient resistance comparatively to be hard to oxidize and generate heat. As for the particle size of these metal particles, it is desirable that it is 0.1-100 micrometers. It is because will be easy to oxidize if too detailed, it will be hard coming to sinter if too large, and resistance becomes large.
[0016] As a resin used for an electric conduction paste, an epoxy resin, phenol resin, etc. are good. Moreover, isopropyl alcohol etc. is used as a solvent. A cellulose etc. is mentioned as a thickener.
[0017] It is desirable to have included the metallic oxide in the aforementioned electric conduction paste in addition to metal particles, and to have made it sinter metal particles and a metallic oxide for a heating element. This reason is for sticking a nitride ceramic or a carbide ceramic, and metal particles. Although the reason the adhesion of a nitride ceramic or a carbide ceramic, and metal particles is improved by the metallic oxide is not clear, the oxide film is formed slightly, these oxide films sintered and unified the front face of a metal-particles front face and a nitride ceramic, or a carbide ceramic through the metallic oxide, and it is presumed whether metal particles, a nitride ceramic, or a carbide ceramic sticks.
[0018] As the aforementioned metallic oxide, at least one or more sorts chosen from a lead oxide, a zinc oxide, a silica, boron oxide (B-2 O3), an alumina, a yttria, and a titania are good. These oxides are because adhesion with metal particles, a nitride ceramic, or a carbide ceramic can be improved without enlarging the resistance of a heating element.
[0019] In the invention in this application, the front face of a heating element is covered with a metal layer, and its bird clapper is desirable. A heating element is a sintered compact of metal particles, and resistance will change that it will be easy to oxidize if it has exposed. Then, oxidization can be prevented by covering a front face with a metal layer. Metal layer thickness has desirable 0.1-10 micrometers. It is because it is the range which can prevent oxidization of a heating element, without changing the resistance of a heating element.
[0020] The metal used for covering should just be a metal of a non-oxidizing quality. Specifically, at least one or more sorts chosen from gold, silver, palladium, platinum, and nickel are good. Nickel is suitable especially. Although the terminal for connecting with a power supply is required for a heating element and this terminal is attached in a heating element through solder, nickel is because the thermal diffusion of solder is prevented. An end-connection child can use the terminal pin made from covar.
[0021] Moreover, solder can use alloys, such as silver-lead and lead-tin and bismuth-tin. In addition, solder layer thickness has desirable 0.1-50 micrometers. It is because it is sufficient range to secure connection by solder. In the invention in this application, a thermocouple can be embedded to a heater board if needed. It is because the temperature of a heater board can be measured with a thermocouple, voltage and the amount of current can be changed based on the data and the temperature of a heater board can be controlled.
[0022] Moreover, as shown in drawing 2 , two or more breakthroughs 8 can be formed in the heater

board 1, the support pin 7 can be inserted in the hole 8, and the semiconductor wafer 9 can be laid on the pin 7. Moreover, the conveyance machine which is made to go up and down the support pin 7, and does not illustrate the semiconductor wafer 9 can be passed, or the semiconductor wafer 9 can be received from a conveyance machine.

[0023] Subsequently, the manufacture method of a heater is explained.

(1) The process which forms the plate (heater board) which is made to sinter the fine particles of a nitride ceramic or a carbide ceramic, and consists of a nitride ceramic or a carbide ceramic. Sintering acids, such as a yttria, and a binder are made into the shape of granulatio by methods, such as spray dry, the fine particles of carbide ceramics, such as nitride ceramics, such as alumimium nitride mentioned above, or silicon carbide, and if needed, this granulatio is put into metal mold etc., and is pressurized, it fabricates to a tabular, and a generation form is manufactured.

[0024] The crevice embedding the breakthrough which inserts the support pin of a semiconductor wafer in a generation form if needed, or a thermocouple can be prepared. Next, carry out heating baking, this generation form is made to sinter, and the plate made from a ceramic is manufactured. A heater board without pore can be manufactured by pressurizing in the case of heating baking. Although heating baking should just be more than sintering temperature, it is 1000-2500 degrees C with a nitride ceramic or a carbide ceramic.

[0025] (2) Process which prints the electric conduction paste which becomes a plate made from the ceramic of ** (heater board) from metal particles. An electric conduction paste is a fluid with the viscosity high generally which consists of metal particles, a resin, and a solvent. This electric conduction paste is printed into the portion which is going to prepare a heating element by screen-stencil etc. Since a heating element needs to make the whole heater board uniform temperature, it is desirable to print to the pattern which consists of a concentric circle as shown in drawing 1 .

[0026] (3) The process which heats, is made to sinter an electric conduction paste and prepares a heating element in the front face of the plate made from a ceramic (heater board). Metal particles are made to sinter, while carrying out heating baking of the electric conduction paste and removing a resin and a solvent. If the metallic oxide is added during the electric conduction paste which is 500-1000 degrees C, since the plate and metallic oxide made from metal particles and a ceramic will sinter and unify, the adhesion of heating burning temperature of a heating element and the plate made from a ceramic improves.

[0027] (4) It is desirable to cover a metal layer on a heating element front face further. Although electrolysis plating, electroless plating, and sputtering can perform covering, electroless plating is the optimal if mass-production nature is taken into consideration.

(5) Attach the terminal for connection with a power supply in the edge of the pattern of a heating element with solder.

[0028] After printing a soldering paste to an attachment part, a reflow of the terminal is put, heated and carried out. 200-500 degrees C is suitable for heating temperature. Furthermore, a thermocouple can be embedded if needed. Hereafter, it explains in accordance with an example.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

EXAMPLE

[Example]
(Example 1) The constituent which consists of the alumimium nitride ceramic board (1) alumimium-nitride powder (1.1 micrometers of mean particle diameters) 100 weight section, the yttria (0.4 micrometers of mean particle diameters [A yttrium oxide]) 4 weight section, the acrylic BAIDA 12 weight section, and alcohol was made into the shape of granulatio by the spray-dryer method.
[0030] (2) Granulatio-like powder was put into metal mold, it fabricated to plate-like, and the generation form was acquired. Drilling was carried out to the generation form and the crevice the hole 8 which inserts a semiconductor wafer support pin, and for embedding a thermocouple, although not illustrated was prepared.
(3) It is a generation form 1800 degrees C and pressure 230 kg/cm2 The hotpress was carried out and the alumimium nitride plate with a thickness of 3mm was obtained. This was started with a diameter of 230mm in the shape of a circle, and it considered as the plate 1 made from a ceramic (heater board).
[0031] To the heater board 1 obtained by (4) and (3), the electric conduction paste was printed by screen-stencil. The printing pattern was used as the pattern of a concentric circle as shown in drawing 1 . The electric conduction paste used the **** chemical research center Solvay strike PS 603. This electric conduction paste is silver / lead paste, and contains a metallic oxide.
(5) Heating baking of the heater board which printed the electric conduction paste was carried out at 780 degrees C, and while making the silver under electric conduction paste, and lead sinter, it printed on the heater board 1. The thickness of the pattern by the sintered compact 4 of silver-lead was 2.4mm in 5 micrometers and width of face.
[0032] (6) The heater board of (5) was immersed in the non-electrolyzed nickel-plating bath which consists of solution of the concentration of nickel-sulfate 80 g/l, sodium hypophosphite 24 g/l, sodium acetate 12 g/l, a 8g [/l.] way acid, and ammonium-chloride 6 g/l, and on the front face of the sintered compact 4 of silver-lead, the nickel layer 5 with a thickness of 1 micrometer was deposited, and was used as the heating element 2.
[0033] (7) From screen-stencil 1, the silver-lead soldering paste was printed into the portion which attaches the terminal for securing connection with a power supply, and the solder layer (product made from the Tanaka noble metals) 6 was formed in it. Subsequently, the terminal pin 3 made from covar was laid on the solder layer 6, a heating reflow was carried out at 420 degrees C, and the terminal pin 3 was attached in the front face of a heating element 2.
(8) The thermocouple for a temperature control (not shown) was embedded and the heater 100 was obtained.
[0034] (Example 2) With the silicon carbide ceramic board example 1, although it was fundamentally the same, the silicon carbide powder of 1.0 micrometers of mean particle diameters was used, and sintering temperature was made into 1900 degrees C.
[0035] It measured about the flattery nature [as opposed to / heater / of examples 1 and 2] change of voltage and the amount of current / of temperature, and the pull intensity of a heating element. When voltage was impressed to the heater, as for the heater of an example 1, the temperature change was seen

in 0.5 seconds, and, as for the heater of an example 2, the temperature change was observed in 2 seconds. the pull intensity of a heating element 2 -- the heater of an example 1 -- the heater of 3.1kg/mm2 and an example 2 -- 3kg/mm2 it was .

[0036] (Example of comparison) Using the nichrome wire pinched by silicone rubber as an aluminum plate heating element, it hit with the aluminum plate with a thickness of 15mm, and the heating element was inserted, it fixed with the bolt, and the board was used as the heater. 24 seconds was taken to see a temperature change, when voltage was impressed to the heater of the example of comparison.

[Translation done.]

* NOTICES *

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DESCRIPTION OF DRAWINGS

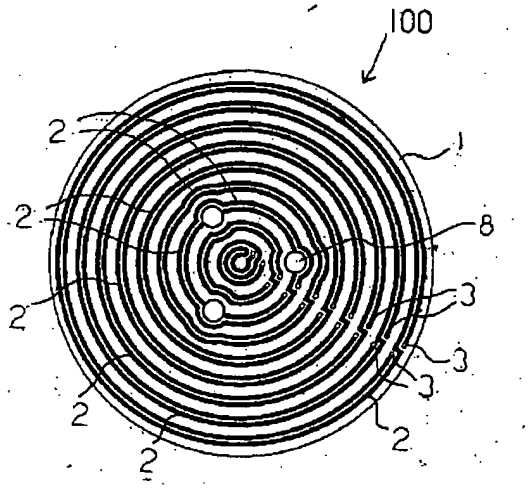
[Brief Description of the Drawings]
[Drawing 1] The ** type view of the heater of the invention in this application
[Drawing 2] The cross section showing the busy condition of the heater of the invention in this application
[Description of Notations]
1 Plate made from Ceramic (Heater Board)
2 Heating Element
3 Terminal Pin
4 Metal (Silver-Lead) Particle Sintered Compact
5 Metal (Nickel) Enveloping Layer
6 Solder Layer
7 Semiconductor Wafer Support Pin
8 Breakthrough
9 Semiconductor Product
100 Heater

[Translation done.]

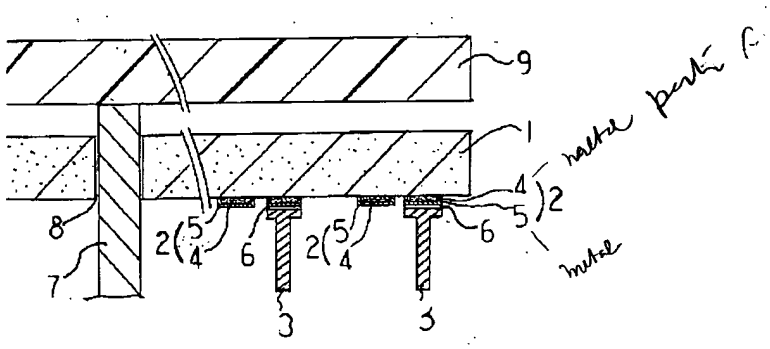
* NOTICES *

DRAWINGS

[Drawing 1]



[Drawing 2]



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CORRECTION or AMENDMENT

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[Item(s) to be Amended] 0022.
[Method of Amendment] Change.
[Proposed Amendment]
[0022] Moreover, as shown in drawing 2, two or more breakthroughs 8 can be formed in a heater board, the support pin 7 can be inserted in the hole 8, and the semiconductor wafer 9 can be laid in an opposite side with the side in which the heating element 2 is formed through the pin 7. Moreover, the conveyance machine which is made to go up and down the support pin 7, and does not illustrate the semiconductor wafer 9 can be passed, or the semiconductor wafer 9 can be received from a conveyance machine.

[Translation done.]